Econ 311: Behavioral and Experimental Economics

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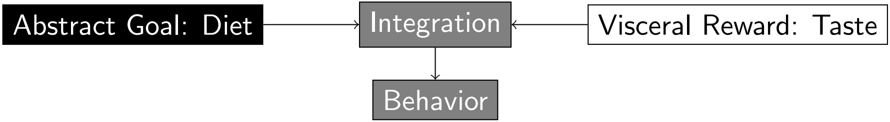
Neuroeconomics

Neuroeconomics

- *Neuroeconomics* is the study of economic decision-making through its biological foundations in the brain
- What are these biological foundations?
  - Neural mechanisms like neurons, chemical pathways, brain systems
  - Genetics
- How do we study these foundations?
  - Scans like PET, CAT, MRI
  - Secondary reactions like skin conductance, pulse rate, eye tracking

Multiple Systems Hypothesis

- One possible neuroeconomic way to study behavior is the *multiple systems model*
- The model:
  - Brain is built up from many independent systems
  - Each system has a physical locus in the brain, and is specialized for a certain task or activity
  - Given a stimulus, each system produces a (potentially different) response
  - The brain integrate these multiple signals to decide on a final course of action
- Example: do you want a cookie right now?

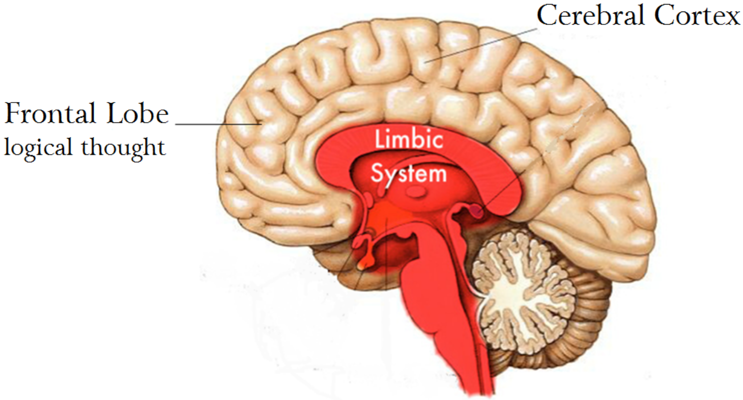


Connection to System 1 and 2

- The multiple systems model sounds a lot like Kahneman's System 1 and System 2
- However, system 1 and system 2 is just one example of a multiple systems hypothesis
- Other examples?
  - Frued's id, ego, and superego
  - Prefrontal cortex vs Mesolimbic dopamine system
  - Deliberative vs impulsive
  - Patient vs myopic
- Note that there can be more than two systems interacting in general

An Over-Simplified Model of the Brain

- Prefrontal cortex (PFC): the center higher reasoning, logic, self control
- Limbic system: releases dopamine in response to rewards like food and sex



Relation to Time Preferences and Self-Control

- Hypothesis: the PFC is patient but the limbic system is impatient
- Preferences are derived from adding up the outputs of the two systems
- For example, consider how the two systems evaluate the prospect of getting a small reward each period:

Period	1	2	3	4
PFC contribution	1	1	1	1
Limbic contribution	1	0	0	0
Average signal	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$

- What do total decision weights look like? Quasi-hyperbolic discounting model with $\beta = \frac{1}{2}$ and $\delta = 1$

Testing the Hypothesis

- How do we test this hypothesis?
  - If we can vary the relative signal strength of the two systems, we should make individuals appear more or less patient
- How can we easily implement this?
  - If we tax or distract the PFC, people should look more impatient
  - Alternatively, we can directly look at the signal strength with brain scans

Cognitive Load

- Shiv and Fedorikhin (1999) ask people to remember a number
- While holding the number in their head, they are asked if they want cake or fruit
- Two treatments:
  - High cognitive load: 7 digit number
  - Low cognitive load: 2 digit number
- Results:
  - High cognitive load: 63% choose cake
  - Low cognitive load: 41% choose cake
- Two systems explanation?
  - PFC is distracted by cognitive load, so relative contribution to decision is smaller
- Any alternate explanations?
  - Could be that remembering longer numbers just makes you hungrier

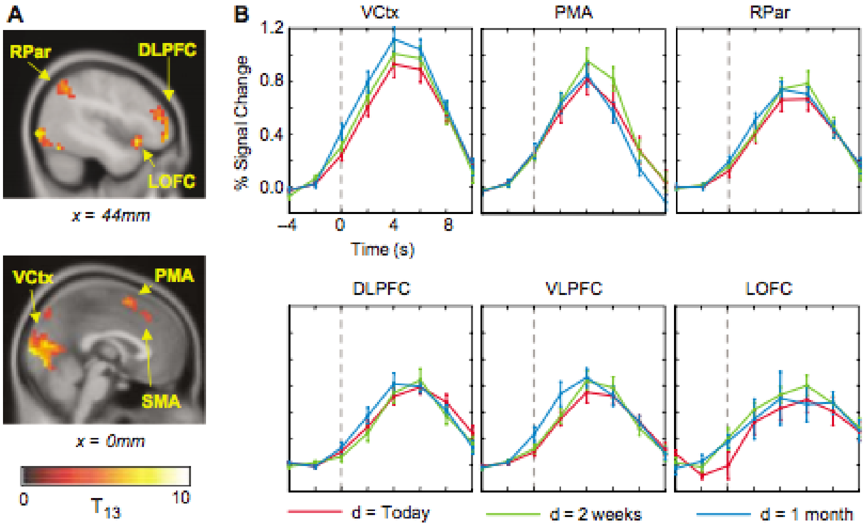
Discount Rates

- Hinson, Jameson, and Whitney (2003) seek to measure time preferences directly using price list methodology we saw earlier in course
- Subjects choose between smaller, sooner reward and later, larger reward
- Vary the cognitive load in a similar way:
  - Control: no cognitive load
  - Treatment: hold a 5-digit number in memory
- Estimated one-month discount rate:
  - Control: 26.3%
  - Treatment: 49.8%

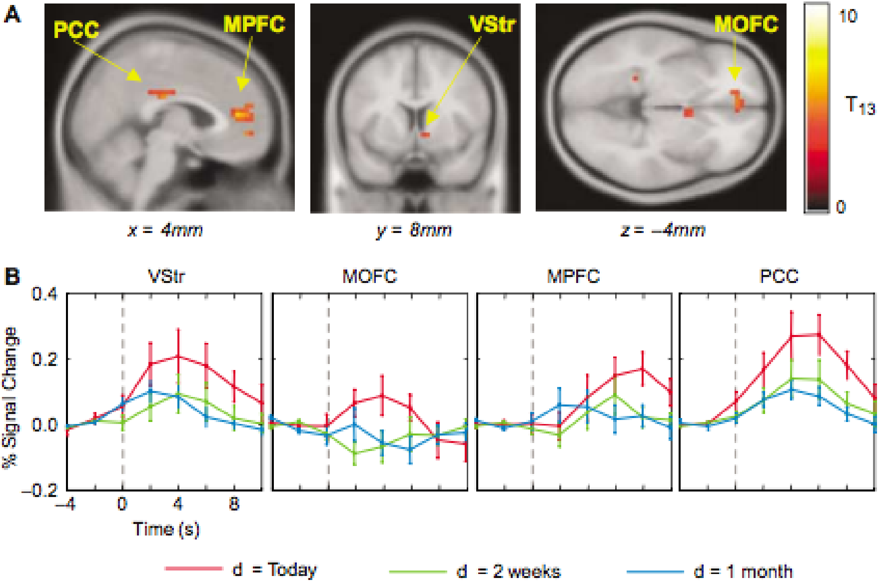
Measuring Brain Activity Directly

- McClure, Laibson, Loewenstein, and Cohen (2004) take a more direct approach
- Attempt to measure the signal coming from each of the two systems
- Task: Subjects make binary decisions between a smaller sooner reward and a larger later reward
  - Sooner period: $d = 0$, 2, or 4 weeks
  - Later period: 2 weeks later
- Predictions of which tasks brain areas will send signal?
  - PFC: Send signal for every task (the δ part of the $\beta - \delta$ model)
  - Limbic system: Send signal only for tasks with $d = 0$ (the β part)

δ Areas Activate for All Options



β Areas Activate Only for Options with Immediate Rewards



Emotion

Emotion in Economics

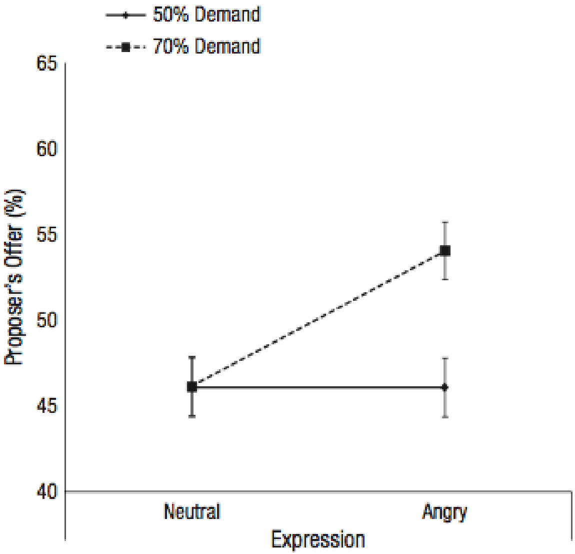
- We tend to avoid directly studying emotion as either an input or output to the decision process
- Why is emotion hard to study directly?
  - Hard to manipulate emotion systematically
  - Very hard to measure emotion other than with self-reports
- However, emotion is clearly a major factor in the kinds of decisions we study in this class
- Examples?
  - Make decisions in risky environments to avoid feeling disappointed
  - Share money in dictator games to avoid feeling guilty

Facial Expressions in the Ultimatum Game

- Reed, DeScioli, and Pinker (2014) examine behavior of proposers in a standard ultimatum game
- Shown short video of a "typical responder" in this game
  - Responder's facial expression was either neutral or angry
- Video was accompanied by a demand for either 50% or 70% of the pie
- 2-by-2 design:

Neutral/50%	Neutral/70%
Angry/50%	Angry/70%

Results



50% Demand
70% Demand
65
60
55
50
45
40
Proposer's Offer (%)
Neutral
Angry
Expression

Regression Model for 2x2 Design

- We can interpret result using regression model:

$$\text{Offer} = \beta_0 + \beta_1 \text{Angry} + \beta_2 \text{Demand70} + \beta_3 \text{Angry} \cdot \text{Demand70} + \varepsilon$$

- Based on graphs what is (approximate) value of
  - β_0? 46%
  - β_1? 0%
  - β_2? 0%
  - β_3? 8%
- Putting predicted offer for each treatment in table can help:

	Demand70 = 0	**Demand70 = 1**
Angry = 0	β_0	$\beta_0 + \beta_2$
Angry = 1	$\beta_0 + \beta_1$	$\beta_0 + \beta_1 + \beta_2 + \beta_3$

Explanations for Results

- What can explain these results?
  - Proposer is scared by aggressive demand paired with angry face
  - Proposer feels that angry responder will be more hurt by a low offer
  - Proposer behaving strategically and avoiding rejections